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# AN IMPORTANT ENTOMOGENOUS FUNGUS

H. S. FAWCETT

(WITH PLATES 28 AND 29, CONTAINING 7 FIGURES)

In 1896, H. J. Webber discovered a fungus parasite of the citrus whitefly and described its sterile form under the name of "Brown mealy-wing fungus (2)." It is now popularly known by the orange growers of Florida as the "Brown fungus" of the whitefly. The spread of this fungus on whitefly larvae,—(1) by means of superficial hyphae that spread over the surface of the leaves attacking every whitefly larva in their way, and (2) by means of spore-like aggregations of cells that may be carried in the air or by insects,—make this fungus one of the most important parasites of the whitefly! This fungus and the red fungus (*Aschersonia Aleyrodis*) are being introduced by orange growers into many localities in Florida with the belief that they are the most economic means yet discovered of keeping the whitefly (*Aleyrodis Citri*) under control.

## SPREAD OF THE FUNGUS BY ARTIFICIAL MEANS

Artificial means of spreading this fungus and *Aschersonia Aleyrodis* have been developed by E. W. Berger, of the Florida Agricultural Experiment Station (12, 13). The two most commonly used are the leaf-pinning method and the spore-spraying method; the first consisting in pinning into a citrus tree fungus-bearing leaves in contact with larva-infested leaves; the second in spraying surfaces of leaves with water containing the spores of the fungi. The latter method has been taken up quite extensively in some orange groves. This is shown by the fact that at the present time there are men in Florida who make it a regular business to spray whitefly-infested orange trees in this way, getting their supplies of fungus spores from citrus leaves on which the fungus has previously developed upon whitefly larvae. Whenever the atmospheric conditions are favorable to

the growth of these fungi, fair success in checking the whitefly has been attained.

#### DEVELOPMENT OF THE FUNGUS

The fungus as it develops upon a larva of the whitefly forms a chocolate-brown (No. 10, Saccardo's Chromotaxia) stroma (*pl.* 28, *f.* 2), which to the unpracticed eye looks like the citrus red scale (*Chrysomphalis Aonidum*). A good description is given of this stage of the development of the fungus by Webber (2) as follows: "The hyphae develop in the body of the insect, burst out around the edges of the scale, and gradually grow up over it. In the early stage they form a brown, compact layer around the edge of the larva. As the fungus develops, the hyphae entirely cover the larval scale, forming a dense, hard, and smooth stroma. The mature stroma is compressed-hemispherical, frequently having a slight depression in the apex over the center of the insect, where the hyphae come together as they spread from the edge of the scale in their development. The hyphae which make up the body of the stroma, are light brown, very tortuous, and but slightly branched. Those in the body of the insect are of similar character, but a much darker brown. From the base of the stroma a ground mycelium, or hypothallus, spreads out in all directions on the surface of the leaf, forming a compact membrane near the stroma, but becoming gradually dispersed into separate filaments." In the later development of the fungus, the separate filaments spoken of by Webber as spreading for a distance of one half inch, grow out over the entire surface of the leaf, branching only sparingly and infecting every larva present. They extend also around the edges and over the upper surface of the leaf. These filamentous hyphae are colorless to slightly tawny with age. They are only occasionally branched, forming a loose, inconspicuous mycelium over the surface of the leaf. On the upper surface of the leaf, on short lateral hyphae, are borne the sporodochia, which are 60 to 90  $\mu$  in diameter. These consist of an aggregation of conidia-like, inflated, spherical cells, 12-18  $\mu$  in diameter. From near the place of attachment of the sporodochium, there radiate 3 to 5 hypha-like appendages, which are 150-200  $\mu$  long by 6-8  $\mu$  wide, and are one- to three-septate (*pl.*

29, f. 5). This entire aggregation of spherical cells and appendages usually remains in union and functions as a spore. When abundant, these sporodochia present to the eye the appearance of a reddish-brown dust over the upper surface of the leaf (*pl.* 28, f. 1). The presence of the brown stromata may easily be known at a distance of 10 to 20 feet by this characteristic appearance. In most cases these sporodochia are found only on the upper surface, but if the lower surface of a leaf happens to be turned over for some time they will develop there also. This condition of the fungus is common in the summer and fall. The sporodochia were first noticed in the fall of 1905, and have been observed since in great abundance every year. The supposed connection of these sporodochia with the brown stromata was touched upon in 1908 (15), but only recently has the connection between the two been proved. The relation of the sporodochia to the spread of the fungus is interesting. When mature, the sporodochium with its accompanying appendages breaks off from the mycelium and remains upon the surface, apparently held lightly by the appendages. The inflated cells make it light, so that when once detached it blows about easily, and on coming in contact with a fairly rough surface it tends to hold fast to it. It seems probable that the appendages may also serve to hold the sporodochia to bodies of large insects that may drag them from one part of the tree to another.

#### GERMINATION OF SPORODOCHIA

These *Aegerita* sporodochia when germinated in hanging-drop cultures of sterile water and in 5 per cent. glucose solution, were seen to produce hyphae (*pl.* 28, f. 3, 4) identical with those which compose the brown stromata on the whitefly larvae. When germinating, the first hyphae grow out either from the sporodochia or from the ends of the appendages. These branch rather sparingly, but in a few days, in 5 per cent. glucose solution, form a network by the intercrossing of the branches (*pl.* 28, f. 4).

#### INOCULATIONS OF WHITEFLY LARVAE

Four different attempts were made to inoculate larvae of whitefly with these sporodochia, three of which were successful. One

of these is here given in detail. The sporodochia were carefully picked off one by one under the compound microscope. A camel's hair brush moistened with water containing these sporodochia was drawn over whitefly-infested leaves on trees at Gainesville, Fla., August 11, 1909. No brown fungus could be found nearer than one and one half miles from this place. In 9 days, the young larvae showed effects of fungus infection. In 16 days, the initial stage of the stromata were evident, bursting through the edges of the larvae (*pl. 29, f. 7*). In a few weeks, the typical brown stromata were produced, but no sporodochia were yet evident. In two or three months, the hyphae had grown around to the upper surface of the leaves and had produced the *Aegerita* sporodochia. On more than a hundred trees not inoculated no brown fungus developed.

Because of the economic importance of this fungus, it has been suggested in Science that it be designated as *Aegerita Webberi* for convenience until the perfect stage is found. The form of the hyphae strongly suggest relationship to the Hypochnaceae of the basidiomycetous fungi, but as yet the basidia spores have not been found. A technical description follows.

### ***Aegerita Webberi* sp. nov.**

Sporodochia superficial, subglobose, whitish when young, turning to reddish-brown when mature, 60–90  $\mu$  in diameter, bearing three to five appendages; conidia-like cells globose to ellipsoid, hyaline, inflated, thin-walled, 12–18  $\mu$  in diameter, persistent, hanging together in chains and clusters; appendages 3 to 5 in number, straight, thick-walled, 2- to 3-septate, rounded at apex, 150–200  $\mu$  long by 6–8  $\mu$  at the base, narrowing to 4–6  $\mu$  near the apex, arising from within near the base of the sporodochium. Fertile hyphae spreading, colorless to slightly tawny with age, sparingly branched, distantly septate, forming a loose mycelium on the upper surface of the leaf. Stromata pustular, chocolate-brown, smooth, with depressed top when young, becoming convex to flat when mature, 0.5–2 mm. in diameter, composed of intercrossing thick-walled hyphae; margin of stroma membranous, gray to tawny, extending 5–15 mm. and giving rise to a wide-spreading mycelium.

Found on larvae of *Aleyrodes Citri* R. & H. and on *A. nubifera* Berger, on the under surface of citrus leaves.

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## EXPLANATION OF PLATES XXVIII AND XXIX

FIG. 1. Sporodochia of *Aegerita Webberi* on upper side of an orange leaf.  $\times \frac{3}{2}$ .

FIG. 2. Brown stromata of *Aegerita Webberi* on lower side of same leaf indicating position of the whitefly larvae that have been parasitized. The three pustules that show white in the figure are of *Aschersonia Aleyrodis* Webber.  $\times \frac{3}{2}$ .

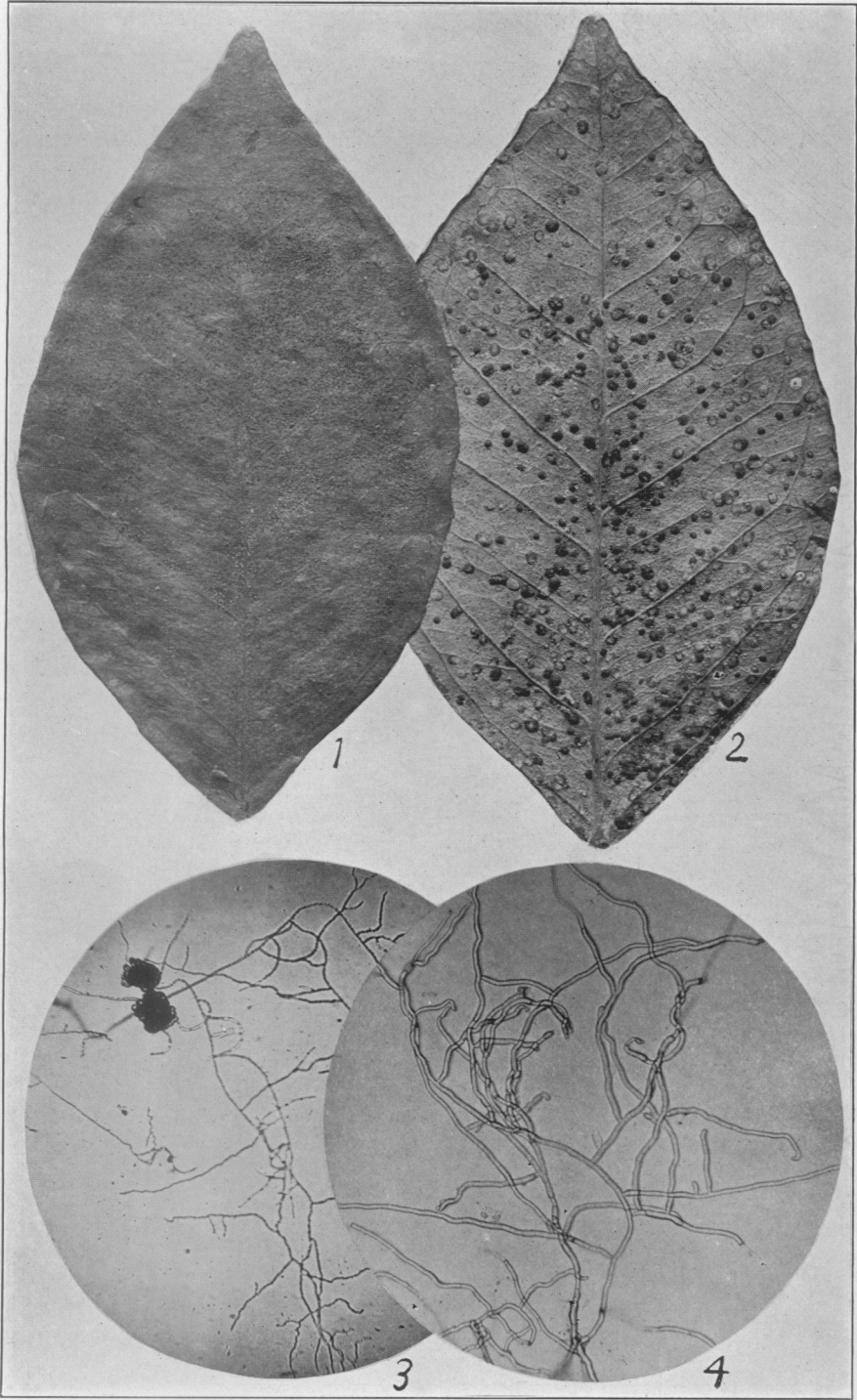
FIG. 3. Two sporodochia of *Aegerita Webberi* germinated in 5 per cent. glucose solution showing growth of mycelium.  $\times 75$ .

FIG. 4. Portion of a mycelium in a hanging-drop culture more highly magnified, showing the intercrossing of the hyphae.  $\times 150$ .

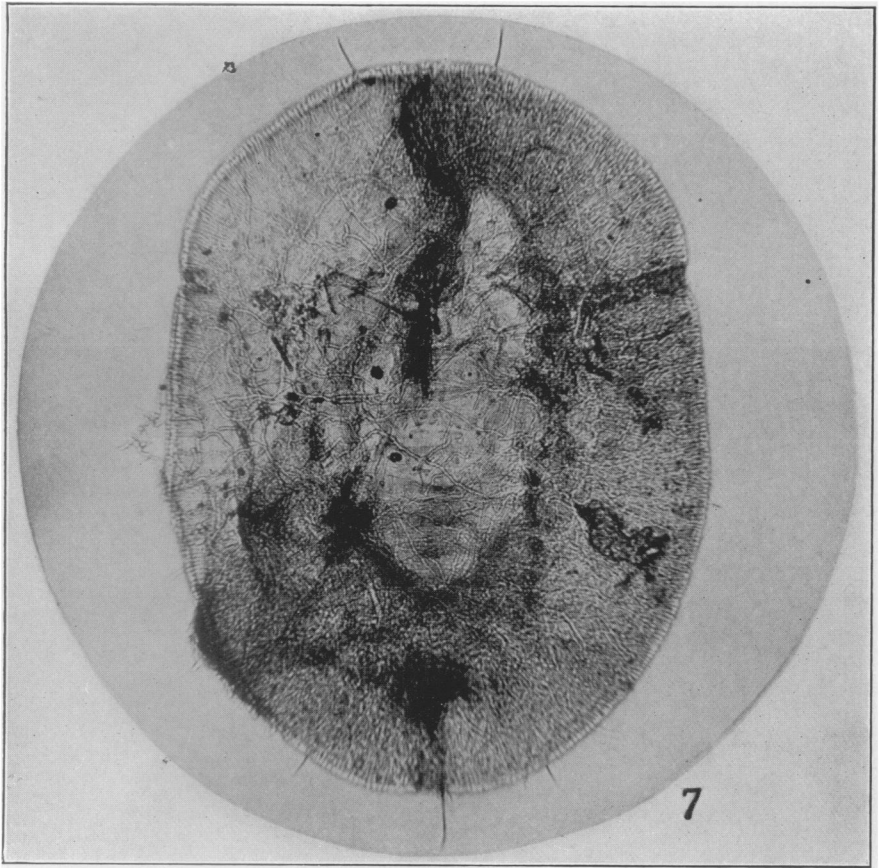
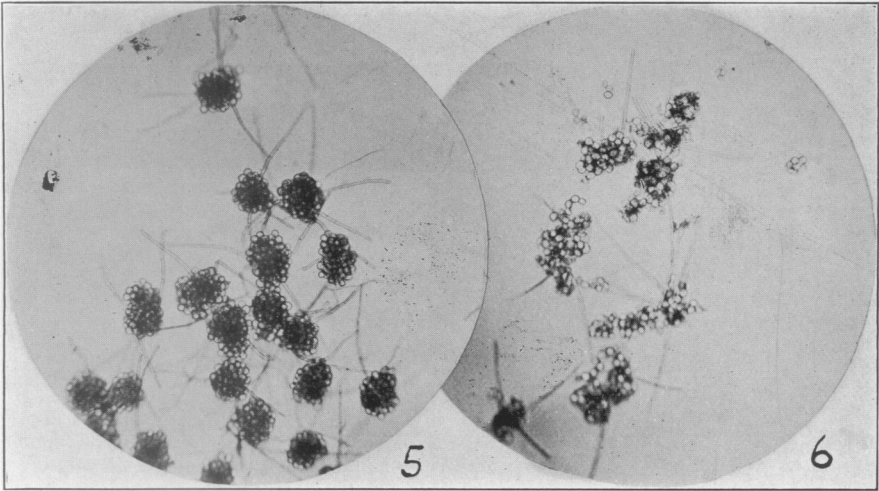
FIG. 5. Sporodochia of *Aegerita Webberi* mounted in water showing conidia-like cells and appendages.  $\times 80$ .

FIG. 6. Same sporodochia broken up under a cover glass to show the clusters and chains of cells.  $\times 80$ .

FIG. 7. Larva of *Aleyrodes Citri* parasitized by inoculation with sporodochia of *Aegerita Webberi*. Near the middle and toward one side, the mycelium of the fungus may be seen very clearly.



AEGERITA WEBBERI FAWCETT



*Aegerita webberi* Fawcett